Constellation-X Spectroscopy X-Ray Telescope (SXT)

Overview - Status and Plans

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NASA/ GSFC

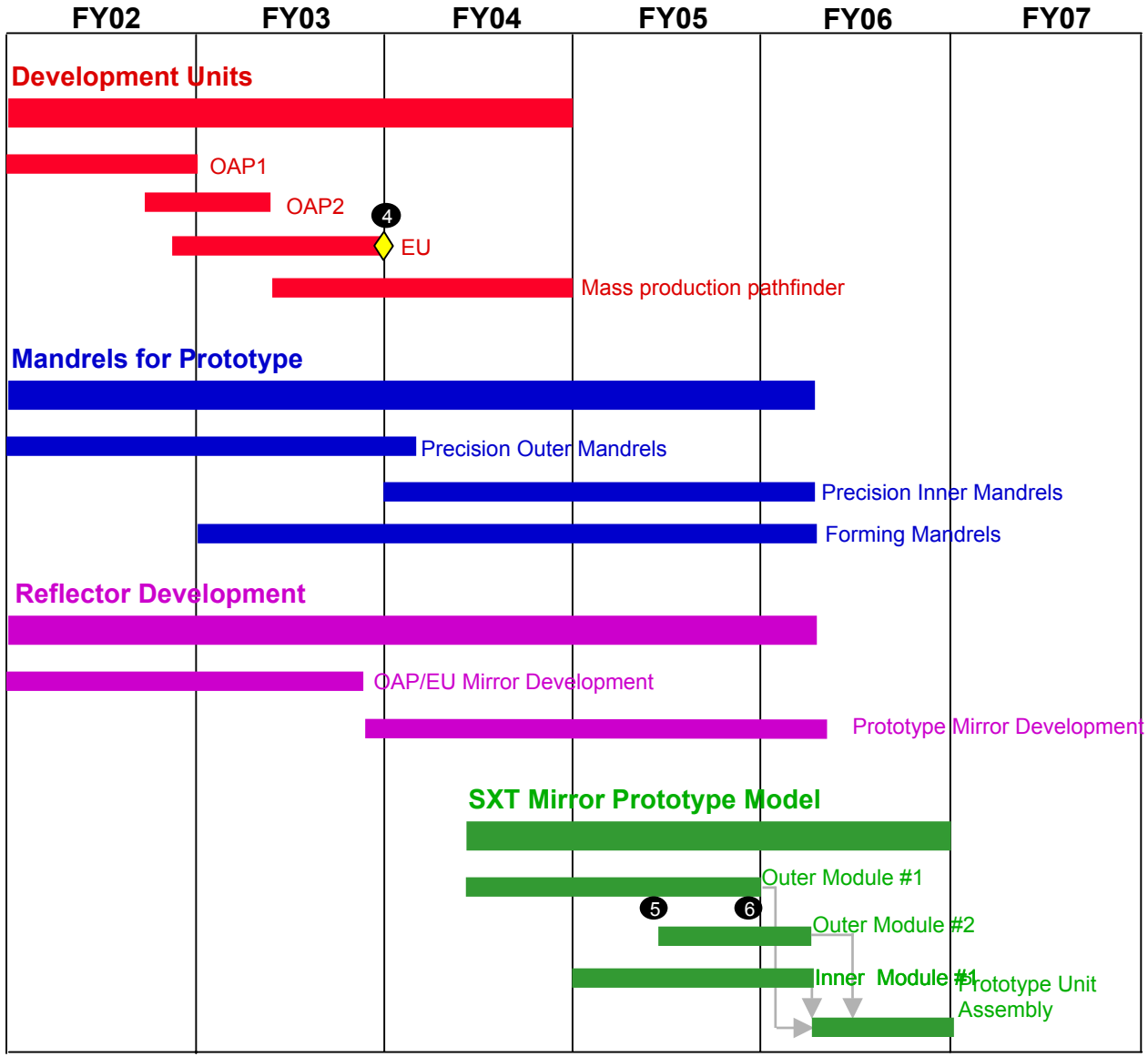
SXT Presentations

Status and Plans	R. Petre	30 min
Large Mandrels / MSFC suport	S. O'Dell	10 min
Reflector Fabrication	W. Zhang	15 min
Metrology	D. Content	10 min
OAP	J. Stewart / J. Hair	10 min
OAP Metrology	S. Owens	10 min

Constellation-X SXT Mirror Parameters

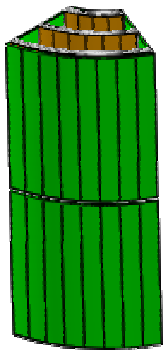
Collecting area per mirror	7,500 cm^2 @ 1 keV	
Mass per mirror	<720 kg	
Angular resolution (half power diameter)	10” (15” for system)	5” system goal
Diameter	1.6 m	
Focal Length	10 m	
f/number	6	
Number of modules	18	
Reflector arc	60°, 30°	
Largest reflector surface area	0.16 m^2	
Substrate material	formed glass	
Substrate density (g cm^{-3})	2.4	
Reflector thickness	0.4 mm	
\Reflector length	20-30 cm	
Number of reflector pairs	230-170	
RMS microroughness	0.4 nm	
Reflector material	gold	

SXT Mirror Technology Roadmap



SXT Development Approach

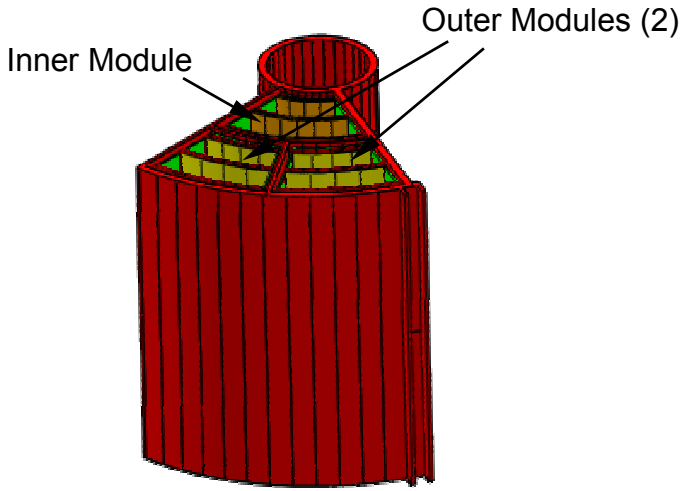
Engineering Unit



Single inner module with

- 0.5 m dia. reflector pair (replicated from Zeiss precision mandrel)
- Parabolic (P) and Hyperbolic (H) submodules
- Mass alignment scheme demonstrated (e.g. Si microstructures).

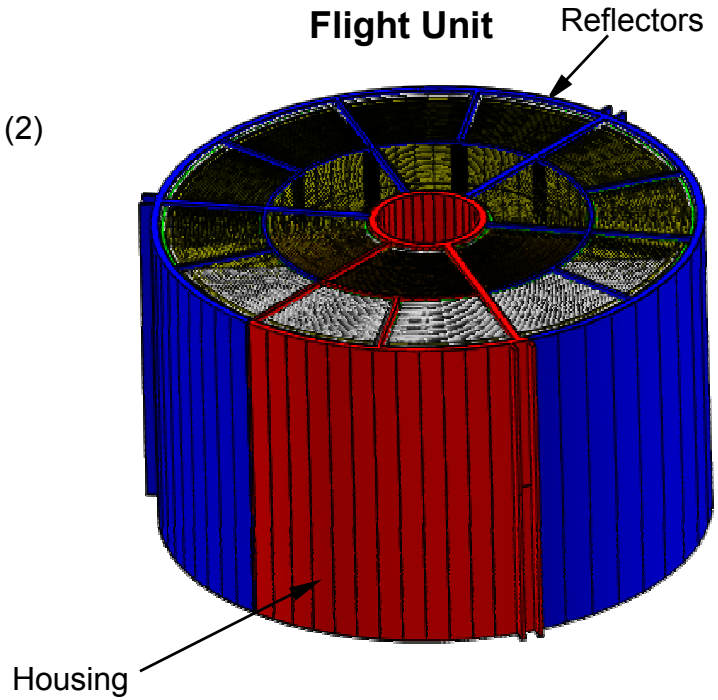
Prototype Unit



Flight Scale Assembly of

- 3 modules (2 outer and 1 inner)
- Largest diameter same as for flight - 1.6 m
- Each module has 3 to 9 reflector pairs
- Demonstrates module to module alignment

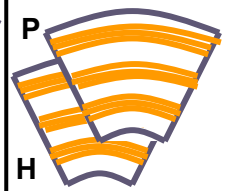
Flight Unit



Full flight Assembly

- 1.6 m outer diameter
- 20-30 cm segment length
- 18 Small Modules
- 170 to 230 reflector diameters

Segmented X-ray Mirror Development Process

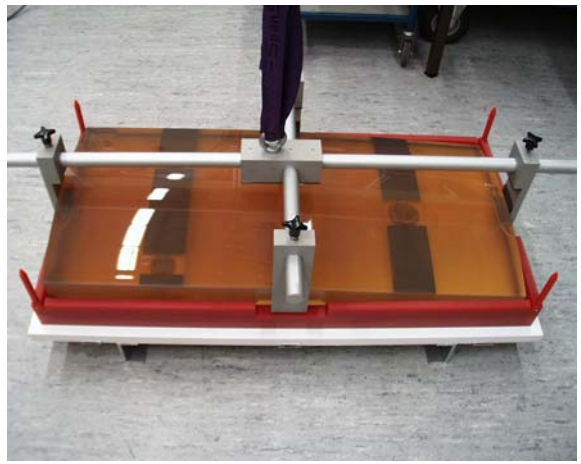
	Optical Assembly Pathfinder		Engineering Unit	Prototype Pathfinder	Prototype		
Configuration							
Module Type	Inner	Inner	Inner	Inner	Outer	Inner	Outer & Inner
Housing Material	Aluminum	Titanium	Titanium	Composite	Composite	Composite	Composite
Focal Length	8.5m	8.5m	8.5m	8.5m	10.0m	10.0m	10.0m
Optic Length (P&H)	2 x 20 cm	2 x 20 cm	2 x 20 cm	2 x 20 cm	2 x 50 cm (TBR)	2 x 50 cm (TBR)	2 x 50 cm (TBR)
Nominal Optic Diameter(s)	50 cm	50 cm±	50 cm±	50 cm±	160 cm± 120 cm± 100 cm±	90 cm± (TBR) 70 cm± (TBR) 50 cm± (TBR)	160 cm± 40 cm± 120 cm± 70 cm± 100 cm± 50 cm±
Goals	▪ Align 1 optical surface pair (P&H) ▪ Evaluate optic alignment techniques, optics assembly design & process, & optics metrology	▪ Align 1 optical surface pair ▪ Evaluate gravity sag ▪ Evaluate mirror bonding	▪ Align up to 3 optical surface pairs to achieve<10arcsec ▪ Gravity sag ▪ Environmental and X-ray test	▪ Align 3 optical surface pairs ▪ Evaluate composite housing ▪ Evaluate tooling and alignment techniques for mass production ▪ X-ray test	▪ Flight-like configuration outer module ▪ Largest optical surfaces ▪ Environmental and X-ray test	▪ Flight-like configuration inner module ▪ Environmental (TBR) and X-ray test	▪ Demonstrate module to module alignment ▪ Environmental and X-ray test
Timeframe	Q4 of FY02	Q2 of FY03	Q1 of FY04	Q4 of FY04	Q4 of FY05	Q2 of FY06	Q4 of FY06

Major Accomplishments

- 1.6 m x 1.2 m segment mandrel delivered by Zeiss.
  - largest mandrel needed for SXT
  - 1.2 and 1.0 m diameter mandrels being fabricated.
  - support infrastructure needs to be developed.
- Have produced 20 cm diameter substrates with figure required for SXT.
  - currently scaling process to 50 cm.
  - have demonstrated ability to form substrates with axial and azimuthal curvature.
- Infrastructure for fabricating and measuring 50 cm diameter reflectors complete.
  - includes furnace, forming & replication mandrels, spray booth, replication station, cutting fixture, interferometer for profile measurement.
- Approach for reflector alignment in housing developed.
  - relies on Centroid Detector Assembly developed for AXAF.
- Initial alignment testbed (OAP1) designed and assembled
  - test reflector mounted and moved using actuators.
- Revised development approach decouples performance testing from development of mass alignment approach.
  - X-ray test of 1-3 reflector pairs in simple, stiff housing (early-mid 2003) at MSFC stray light facility
  - Deferral of introduction of mass alignment approach (Si alignment bars still baseline)
- Bottom Line: All SXT components are at or near their required precision

Delivery of 1.6 m Ziess Mandrel

Mandrel being cleaned by Zeiss technician



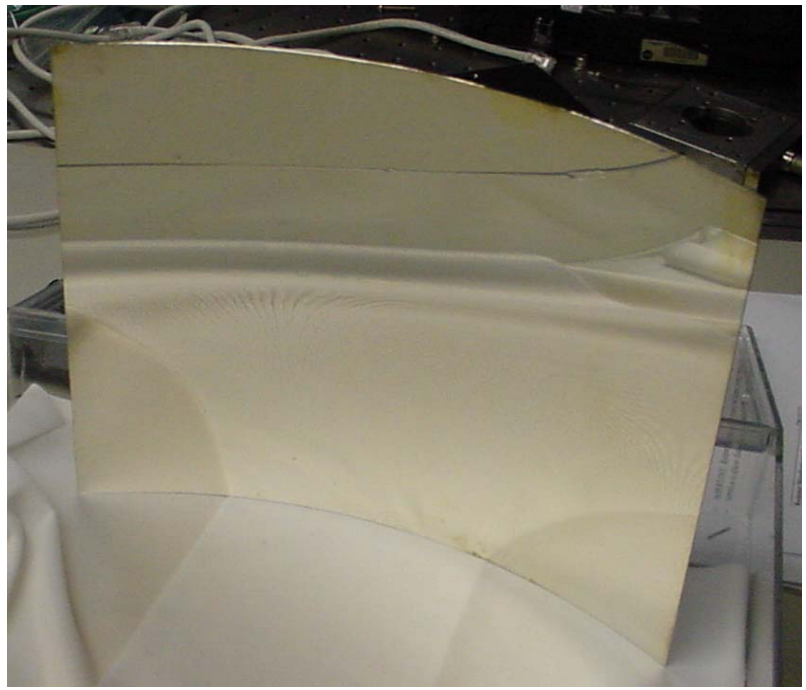
Mandrel in lifting fixture

Lifting fixture being attached

Mandrel in shipping container at MSFC

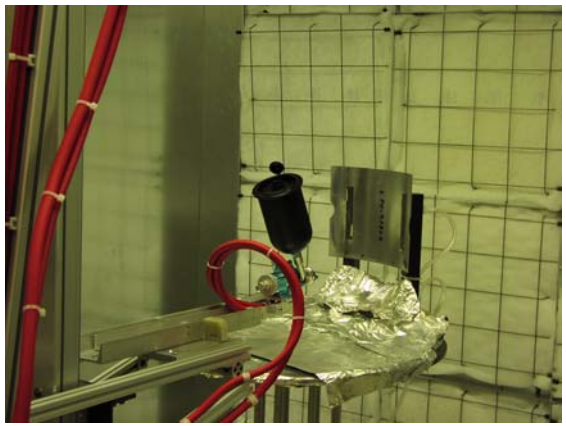
Thermal Forming of Substrates

Thermal forming of substrate using 50 cm mandrel in GSFC 1.5 m furnace.

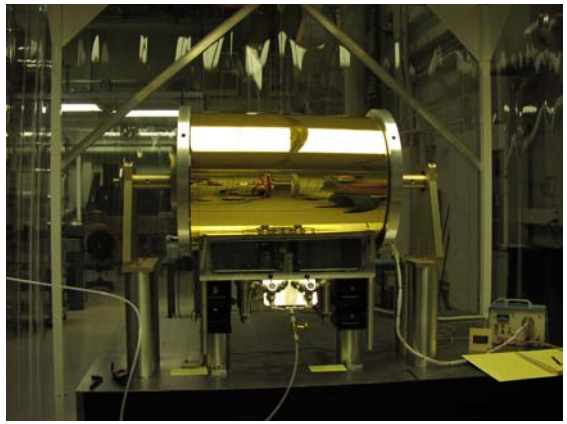


Thermally formed 0.4 mm glass substrate, with 50 cm radius of curvature for SXT EU (with temporary reflecting layer for metrology).

Reflector Replication

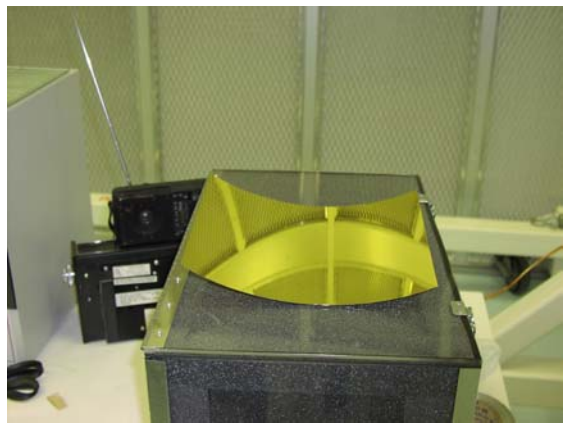


Robotic Spraying of substrate



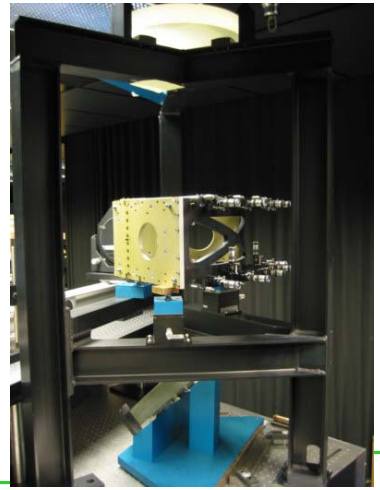
Attachment of substrate to mandrel in vacuum

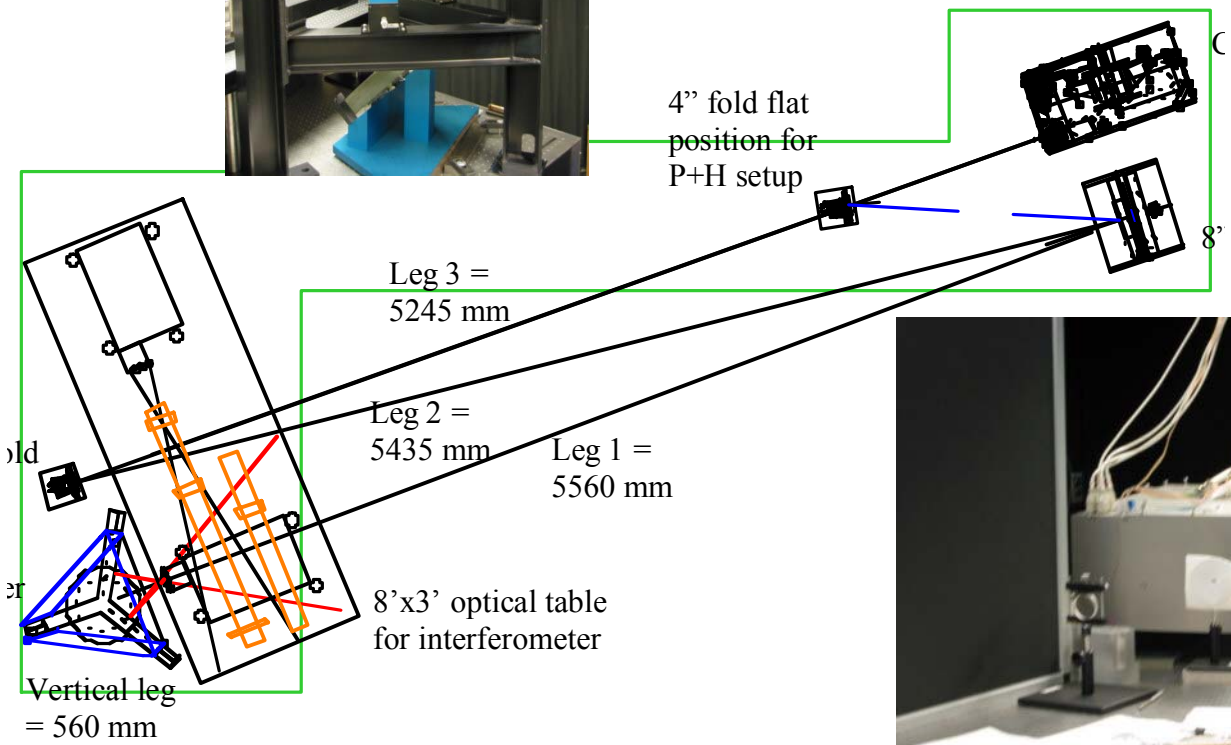
Removal of finished reflector after curing

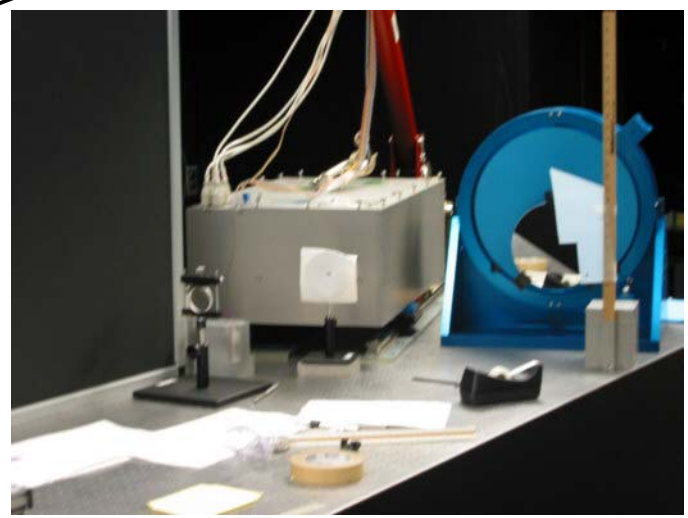


Finished reflector

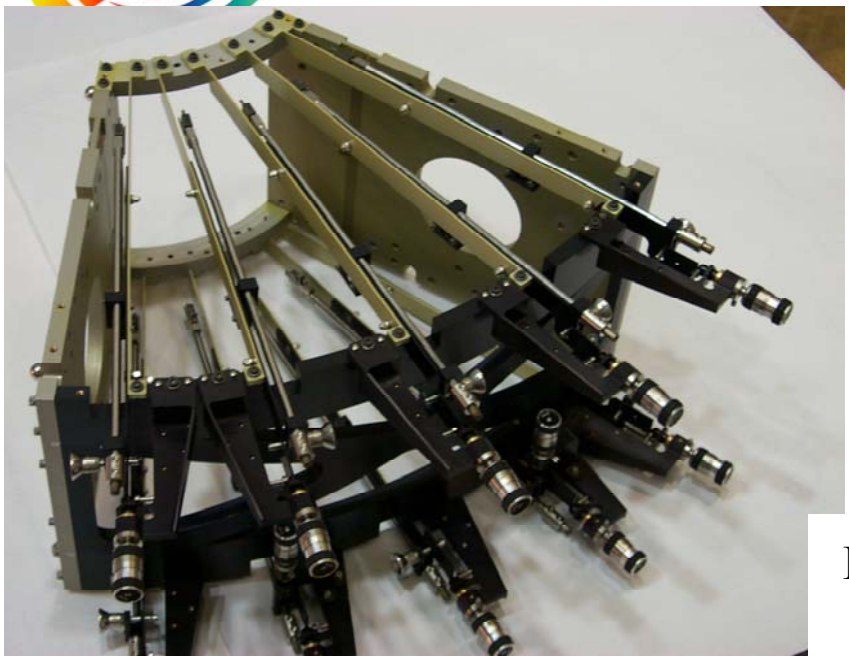
OAP1 Alignment



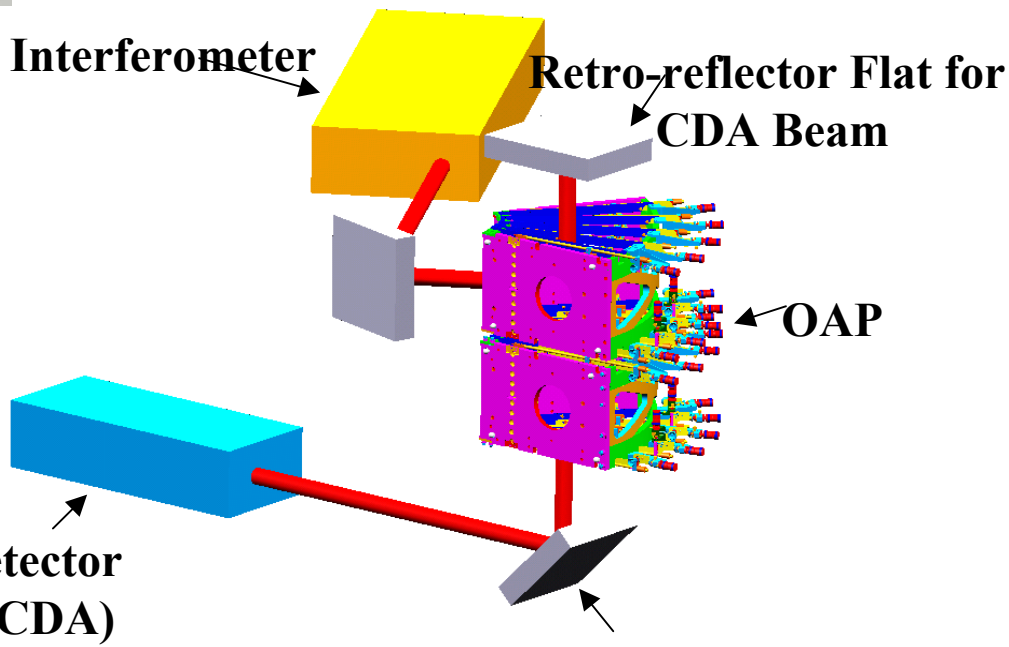




Engineering Unit Housing and Alignment



- Alignment scheme incorporates 5 independent positioners, top and bottom, plus two vertical positioners.
- Interferometer viewing through window in hub provides feedback on figure distortions.
- Centroid Detector Assembly (designed for AXAF mirrors) used to determine focal point and reflector distortions.



SXT Near-Term Plans

- Demonstrate optical performance and alignment techniques using OAP
- Produce 50 cm diameter segments that meet the SXT requirement
- Develop facilities for producing 1.6 m reflectors
  - Replication chamber, deposition chamber
- Buy forming mandrels for 1.6 m reflectors
- Initial X-ray performance verification to take place by end of 2003
- Investigate mass production, alignment and assembly issues